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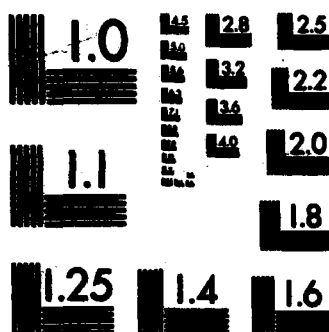
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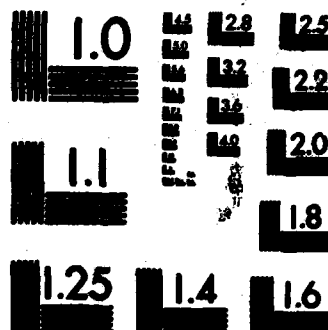
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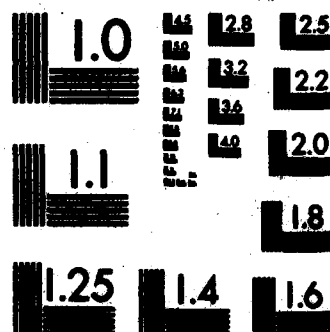
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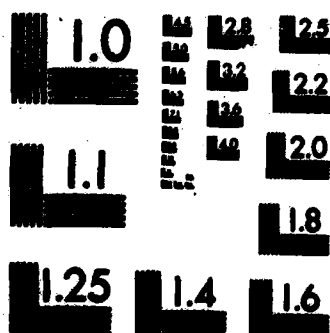
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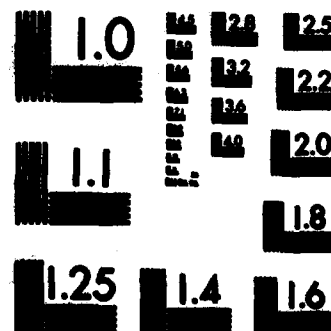
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FINAL REPORT

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19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Shells, Plates, Beams, Domes, Tubes, Laminates, Elasticity, Buckling, Mathematical Theory, Finite Deformation, Composites, Stress Concentrations, Deflection Bounds.		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) Summary of research results on formulation of theories of elastic shells, plates and beams. Results for unconventional beam buckling problems. Results for stress concentrations in shells due to holes or rigid inserts. Deflection bounds for unconventional beam problems.		

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The prototype of a thin body is that of a "shell", such as a spherical shell (sometimes designated as dome), or cylindrical shell (straight tube), or toroidal shell (curved tube). The special case of a shell without curvature in its natural state is usually designated as "plate", still other thin bodies are "beams", for which instead of the adjective "thin" one sometimes uses the adjective "slender."

Examples of the direct approach to the solutions of the problem are to be found in items 27, 29 and 34 in the appended list of Technical Reports. Examples of the use of asymptotic expansion procedures are given by items 7 and 12. Examples of the use of the generalized least-squares procedure are items 4, 8, 9, 18 and 28 in the appended list.

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In addition to the problem of formulating two-dimensional shell theories and one-dimensional beam theories, some of the work done under the terms of the contract has been concerned with solutions or solution procedures for specific problem of technical interest which can be stated within the framework of established two and one dimensional theories. Among these the following are mentioned specifically.

Novel asymptotic results for two-dimensional sixth order theories of shear deformable plates were presented in three reports (5, 23, 31).

Contributions to the understanding of the distribution of stress and strain in laminated anisotropic (composite materials) cylindrical shells were made in report number 6.

Results concerning finite deflections of circular ring plates and toroidal tubes may be found in reports number 11 and 29.

Several investigations have been concerned with non-conventional problems of axial and lateral beam buckling, including the effects of follower forces, shear deformability, and non-coincident centroidal and shear center locations (2, 16, 24, 32).

Altogether five reports have been devoted to the problem of stress concentrations in shallow spherical shells in states of uniform membrane shear or transverse twisting, due to the effect of a small circular hole or rigid inclusion. These problems were recognized, serendipitously, to represent explicitly solvable problems of shell theory (with previously known classical solutions for the special case of flat plates). They were furthermore found to be particularly suitable examples to illustrate the use of an asymptotic expansion procedure for unsymmetrical shell problems which the Principal Investigator had obtained in 1956. Among

the significant consequences of the analysis of these stress concentration problems was the discovery of the existence of shell problems for which the asymptotic "interior" solution contribution displays physically distinct "near-field" and "far-field" behavior, shifting from "membrane" properties to "inextensional bending" properties, in a manner which depends on the nature of the interaction between "interior" and "edge zone" solution contributions (19, 20, 21, 30).

Contributions to an understanding of the concept of a warping boundary layer in one-dimensional beam theory and the relation of this concept to the problem of determining shear center locations in prismatical beams were made in reports number 15, 17 and 22.

Finally, several reports have dealt with the possibility of determining "upper and lower bounds" for influence coefficients in the theory of orthotropic or anisotropic laminated beams, either based on the theory of plane stress or on the theory of torsion of shafts of varying circular cross section (1, 3, 10, 13, 14).

TECHNICAL REPORTS

Contract N0014-75-C-0158

1. Improved Upper and Lower Bounds for Deflections of Orthotropic Cantilever Beams
Int. J. Solids Structures 11, pp. 961-971, 1975
2. Note on a Problem of Beam Buckling
J. Appl. Math. and Phys. (ZAMP) 26, pp. 839-841, 1975
3. On the Determination of Stresses and Deflections for Anisotropic Homogeneous Cantilever Beams
J. Appl. Mech. 43, pp. 75-80, 1976
4. Transverse Bending of Laminated Anisotropic Plates
J. Engg. Mech. Div. (ASCE) 102, EM3, pp. 559-563, 1976
5. On the Theory of Transverse Bending of Elastic Plates
Int. J. Solids Structures 12, pp. 545-554, 1976
6. On Stretching, Bending, Twisting and Flexure of Cylindrical Shells
Int. J. Solids Structures 12, pp. 853-866, 1976
7. On Asymptotic Expansions and Error Bounds in the Derivation of Two-Dimensional Shell Theory
Studies in Appl. Math. 56, pp. 189-217, 1977
8. A Note on Generating Generalized Two-Dimensional Plate and Shell Theories
J. Appl. & Phys. (ZAMP) 28, pp. 633-642, 1977
9. On Small Bending and Stretching of Sandwich-Type Shells
Int. J. Solids Structures 13, pp. 1293-1300, 1977
10. On Bounds for the Torsional Stiffness of Shafts of Varying Circular Cross Section
J. Elasticity 8, pp. 221-225, 1978
11. A Note on Finite Deflections of Circular Ring Plates
J. Appl. Math. & Phys. (ZAMP) 29, pp. 698-703, 1978
12. Two and Three-Dimensional Results for Rotationally Symmetric Deformations of Circular Cylindrical Shells
Int. J. Solids Structures 14, pp. 905-924, 1978
13. Effect of Stress-Free Edges in Plane Shear of a Rectangular Orthotropic Region
J. Appl. Mech. 45, pp. 307-312, 1978
14. A Rayleigh-Ritz Determination of Upper and Lower Bounds for the Deflection of Orthotropic Cantilever Beams
Int. J. Num. Meth. Eng., 12, pp. 885-890, 1978

15. Some Considerations on the Problem of Torsion and Flexure of Prismatical Beams
Int. J. Solids Structures 15, pp. 41-53, 1979
16. On Lateral Buckling of End-loaded Cantilever Beams
J. Appl. Math. & Phys. (ZAMP) 30, pp. 31-40, 1979
17. Note on a Nontrivial Simple Example of Higher-Order One-Dimensional Beam Theory
J. Appl. Mech. 46, pp. 337-340, 1979
18. Note on the Effect of Transverse Shear Deformation in Laminated Anisotropic Plates
Computer Meth. Appl. Mech. & Eng. 20, pp. 203-209, 1979
19. On the Transverse Twisting of Shallow Spherical Ring Caps
J. Appl. Mech. 47, pp. 101-105, 1980
20. On the Effect of a Small Circular Hole on States of Uniform Membrane Shear in Spherical Shells
J. Appl. Mech. 47, pp. 430-431, 1980
21. On the Influence of a Rigid Circular Inclusion on the Twisting and Shearing of a Shallow Spherical Shell
J. Appl. Mech. 47, pp. 586-588, 1980
22. On Torsion and Transverse Flexure of Orthotropic Elastic Plates
J. Appl. Mech. 47, pp. 855-860, 1980
23. On the Analysis of First and Second-Order Shear Deformation Effects for Isotropic Elastic Plates
J. Appl. Mech. 47, pp. 959-961, 1980
24. On the Effect of Shear Center Location on the Values of Axial and Lateral Cantilever Buckling Loads for Singly Symmetric Cross-section Beams
J. Appl. Math. & Phys. (ZAMP) 32, pp. 182-188, 1981
25. On Finite Pure Bending of Curved Tubes
Int. J. Solids Structures 17, pp. 839-844, 1981
26. On a One-Dimensional Theory of Finite Torsion and Flexure of Anisotropic Elastic Plates
J. Appl. Mech. 48, pp. 601-605, 1981
27. On Finite Deformations of Space-Curved Beams
J. Appl. Math. & Phys. (ZAMP) 32, pp. 734-744, 1981
28. A Note on Bending of Plates Including the Effects of Transverse Shearing and Normal Strains
J. Appl. Math. & Phys. (ZAMP) 32, pp. 764-767, 1981

29. On the Derivation of Two-Dimensional Strain Displacement Relations
For Small Finite Deformations of Shear-Deformable Plates
J. Appl. Mech. 49, pp. 232-234, 1982
30. Effects of a Rigid Circular Inclusion on States of Twisting and
Shearing in Shallow Spherical Shells
J. Appl. Mech. 49, pp. 442-443, 1982
31. A Note on the Linear Theory of Shallow Shear-deformable Shells
J. Appl. Math. & Phys. (ZAMP) 33, pp. 425-427, 1982
32. On lateral Beam Buckling and Finite-Deflection Plate Theory
Stability in the Mechanics of Continua, Proc. IUTAM Symposium,
Numbrecht 1981 pp. 23-34, 1982
33. Some Remarks on the Problem of Column Buckling
Ingenieur-Archiv 52, pp. 115-119, 1982
34. A Note on Two-Dimensional Finite-Deformation Theories of Shells
Int. J. Non-Linear Mechanics 17, pp. , 1982